Functional Relationships

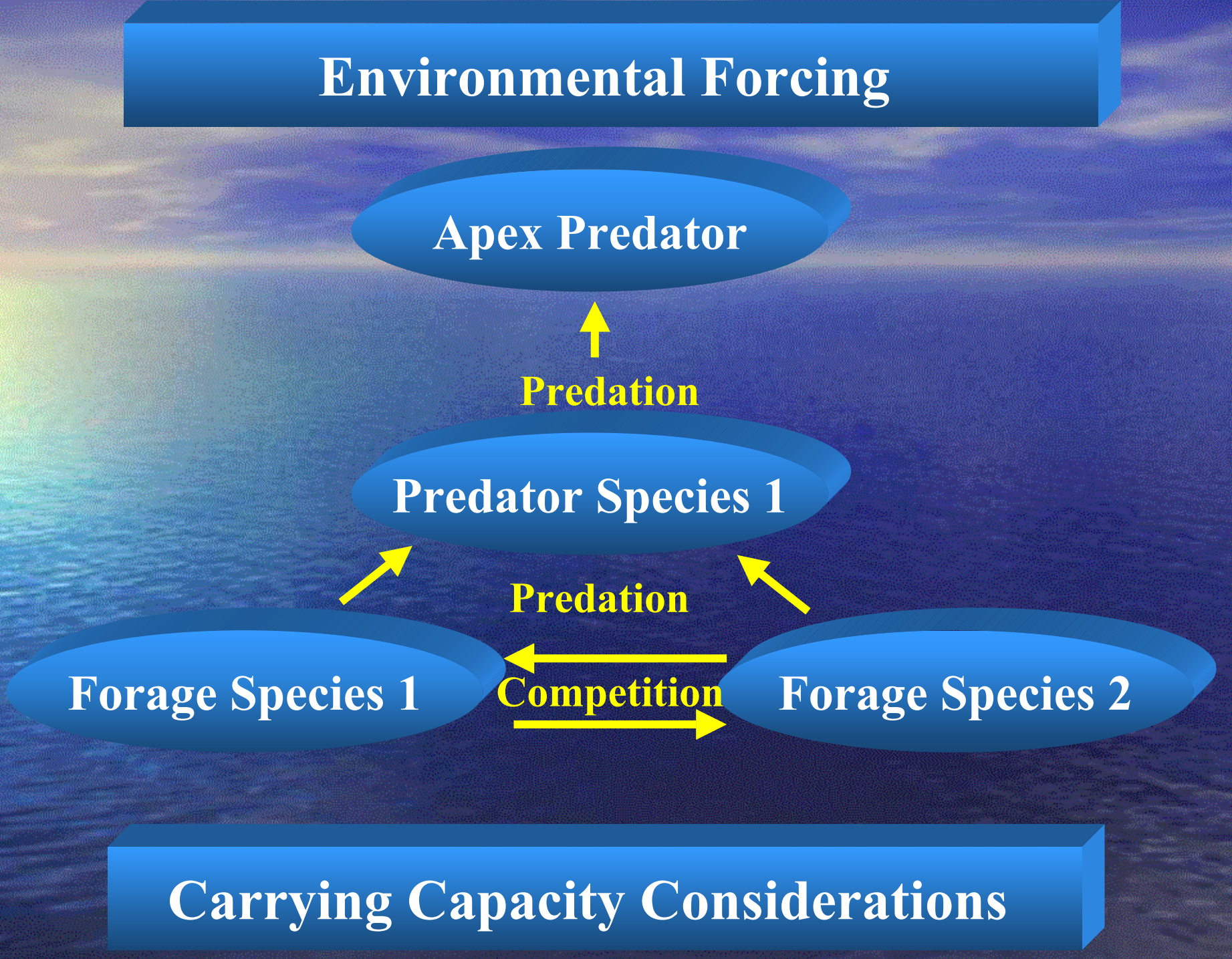
Michael J. Fogarty
Northeast Fisheries Science Center
Woods Hole, MA

Workshop on Ecosystem-Based Decision Support Tools for Fisheries Management
Key Largo 14-18 February 2005

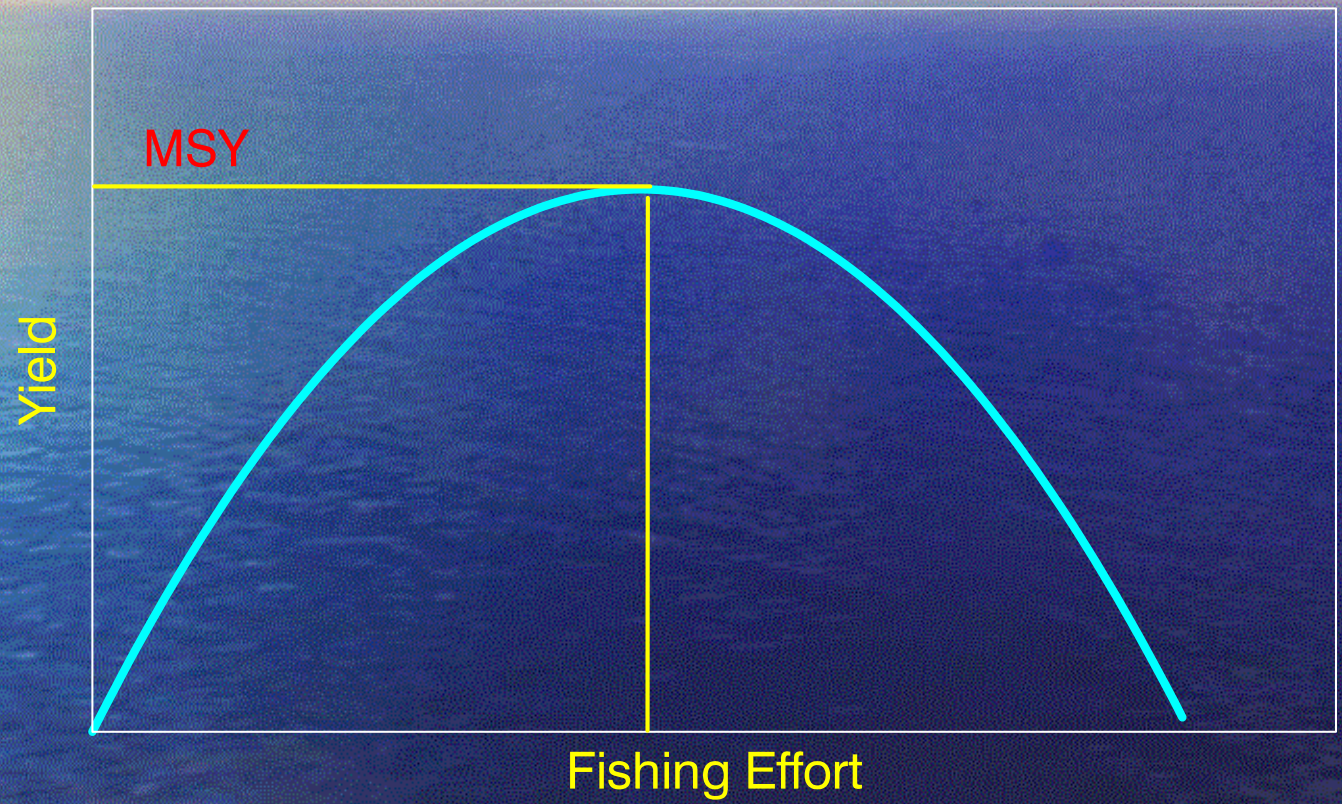
Preview of Coming Attractions

Functional Relationships: Implications for Reference Points

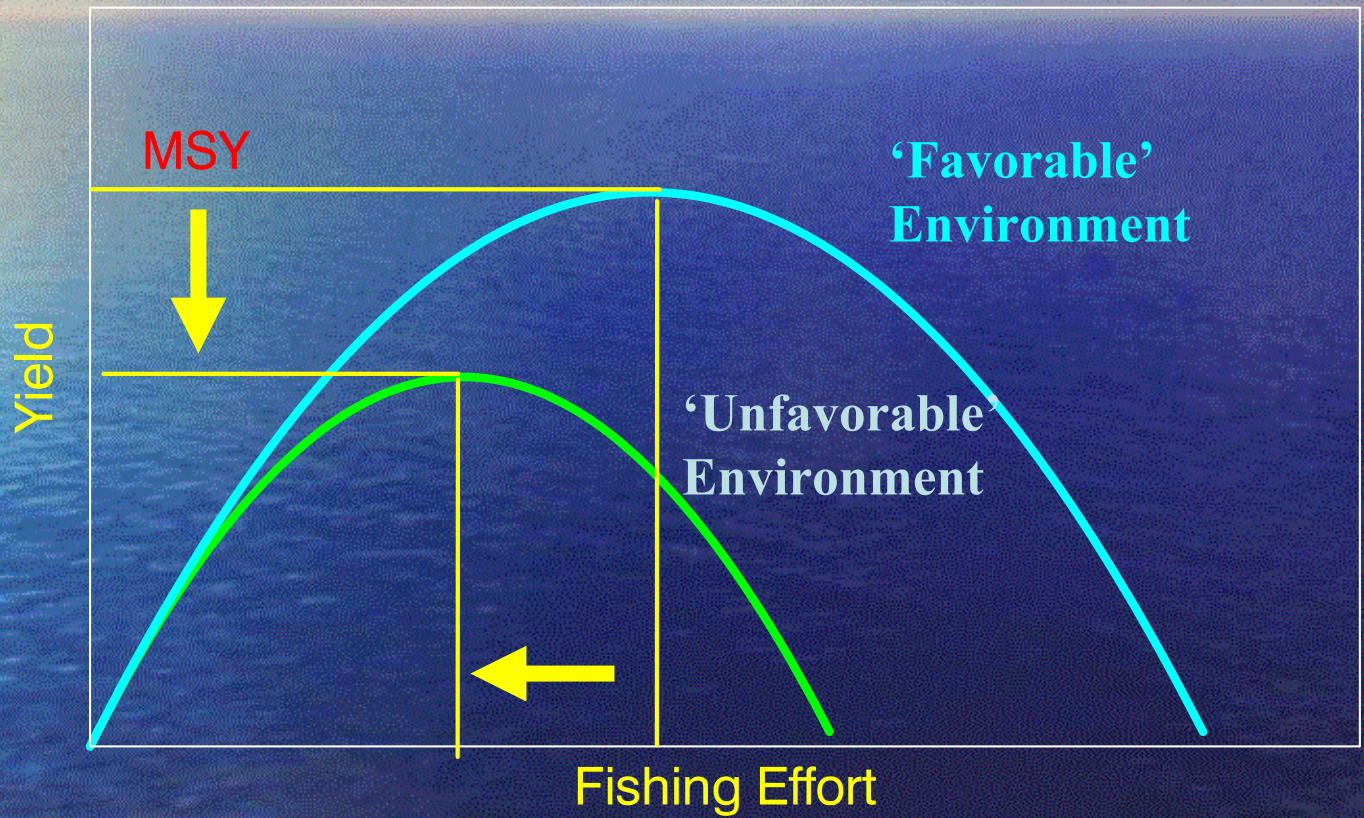
- Effects of Environmental Shifts
- Implications of Habitat-Effects of Fishing
- Multispecies Models: Technical Interactions
  - Multispecies Models:Predator Prey Dynamics
- Multispecies Models: Competition
- Model Complexity and Uncertainty


Environmental Forcing
Apex Predator
Predation
Predator Species 1
Predation
Forage Species 1
Competition
Forage Species 2
Carrying Capacity Considerations

Single Species Dynamics & Reference Points

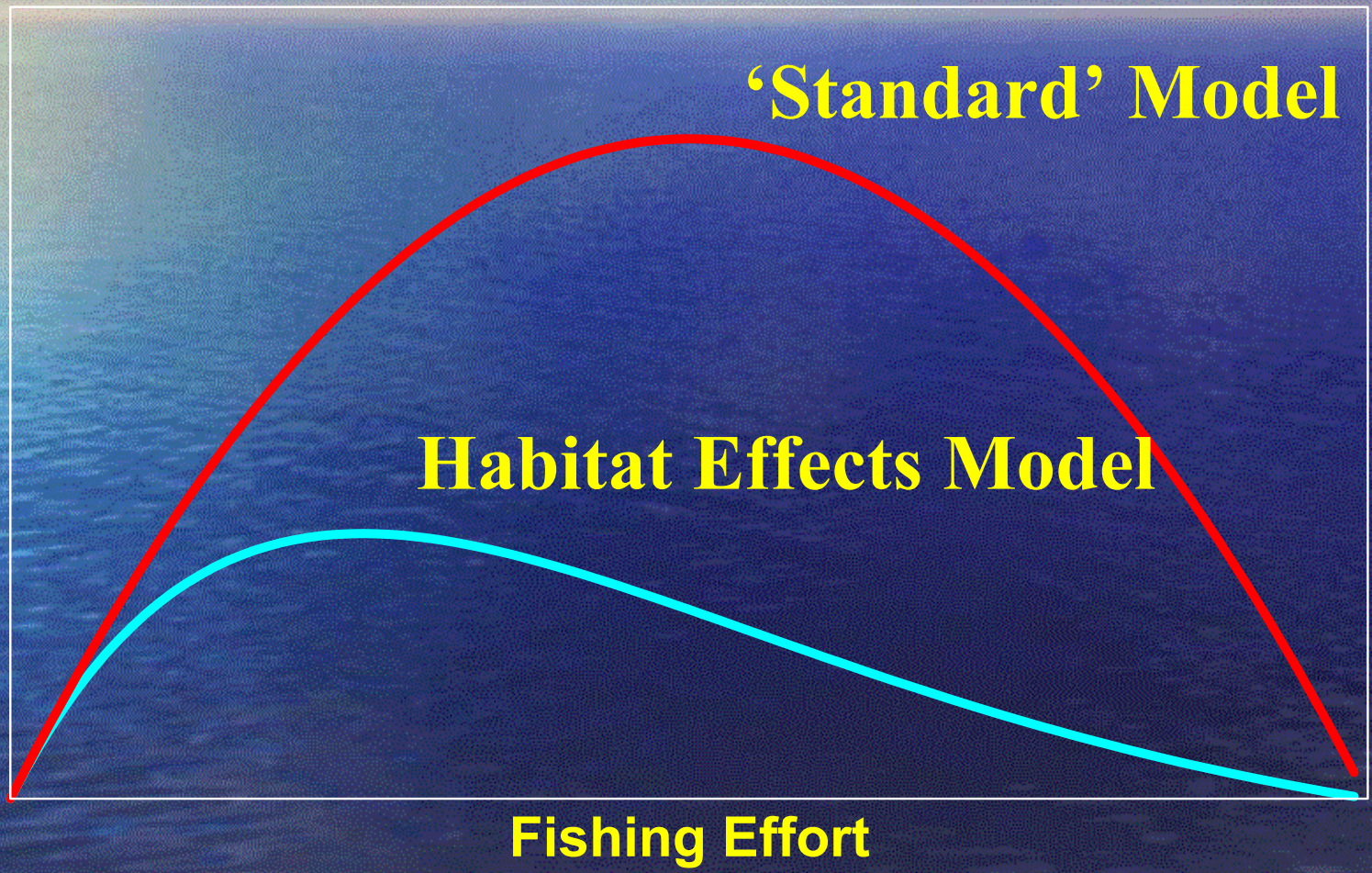


Effects of an Environmental Shift



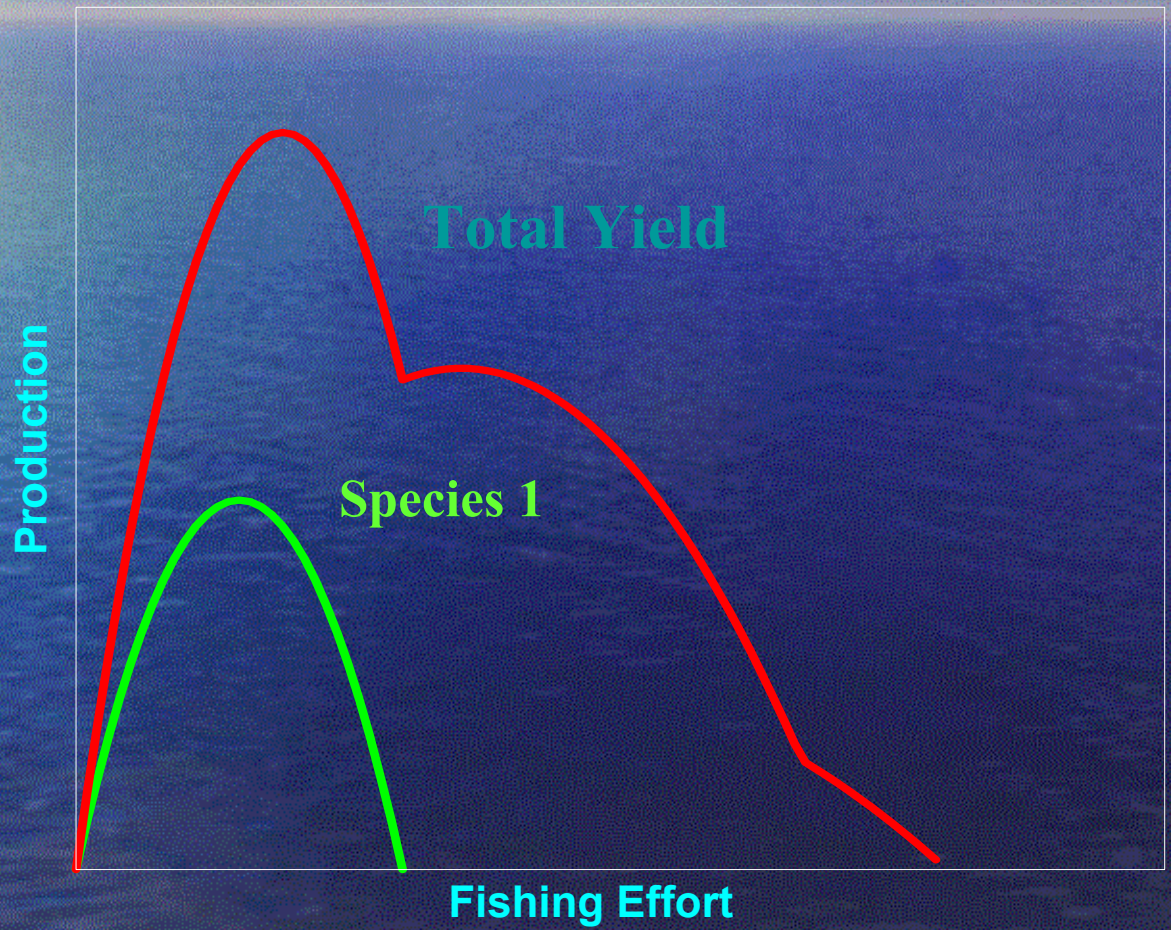
If Intrinsic rate of increase is affected

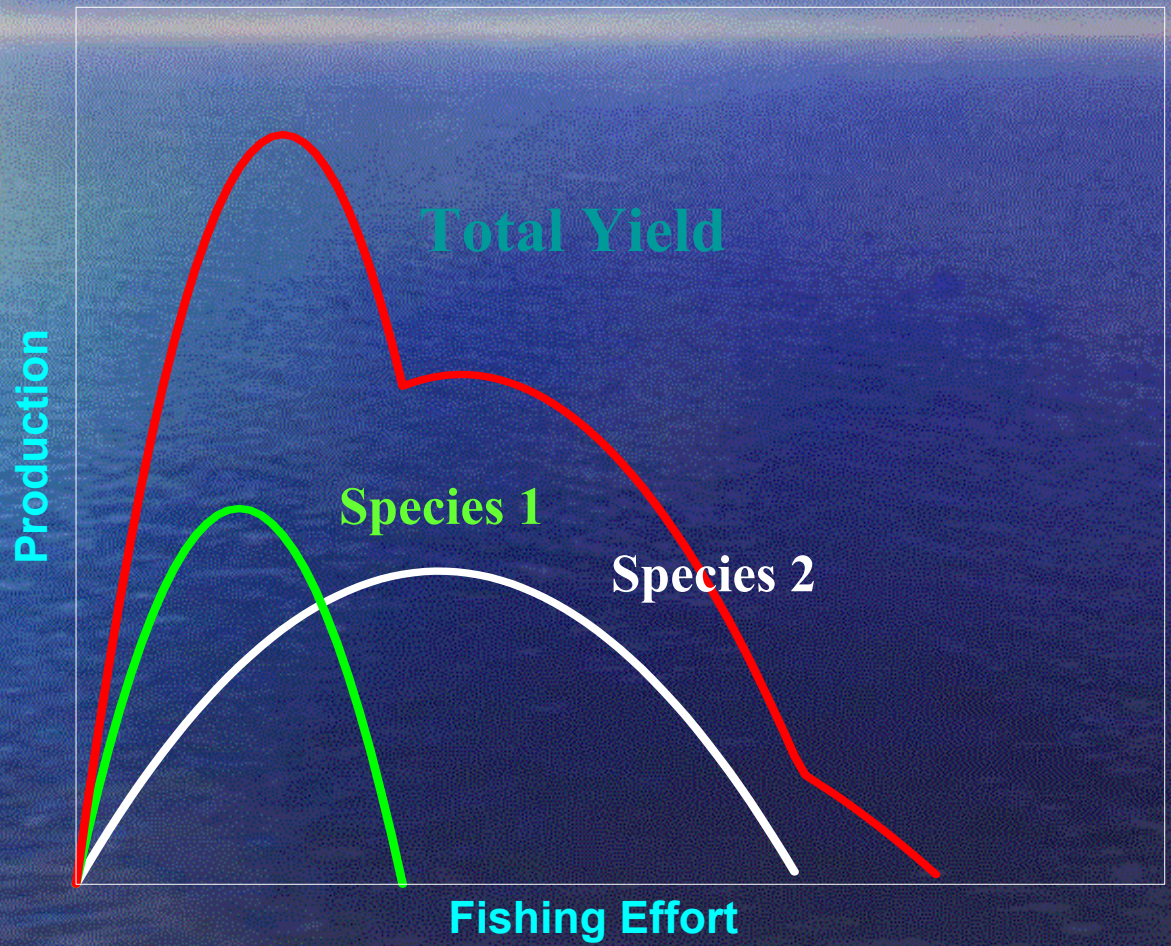
Fishing Effects on Carrying Capacity

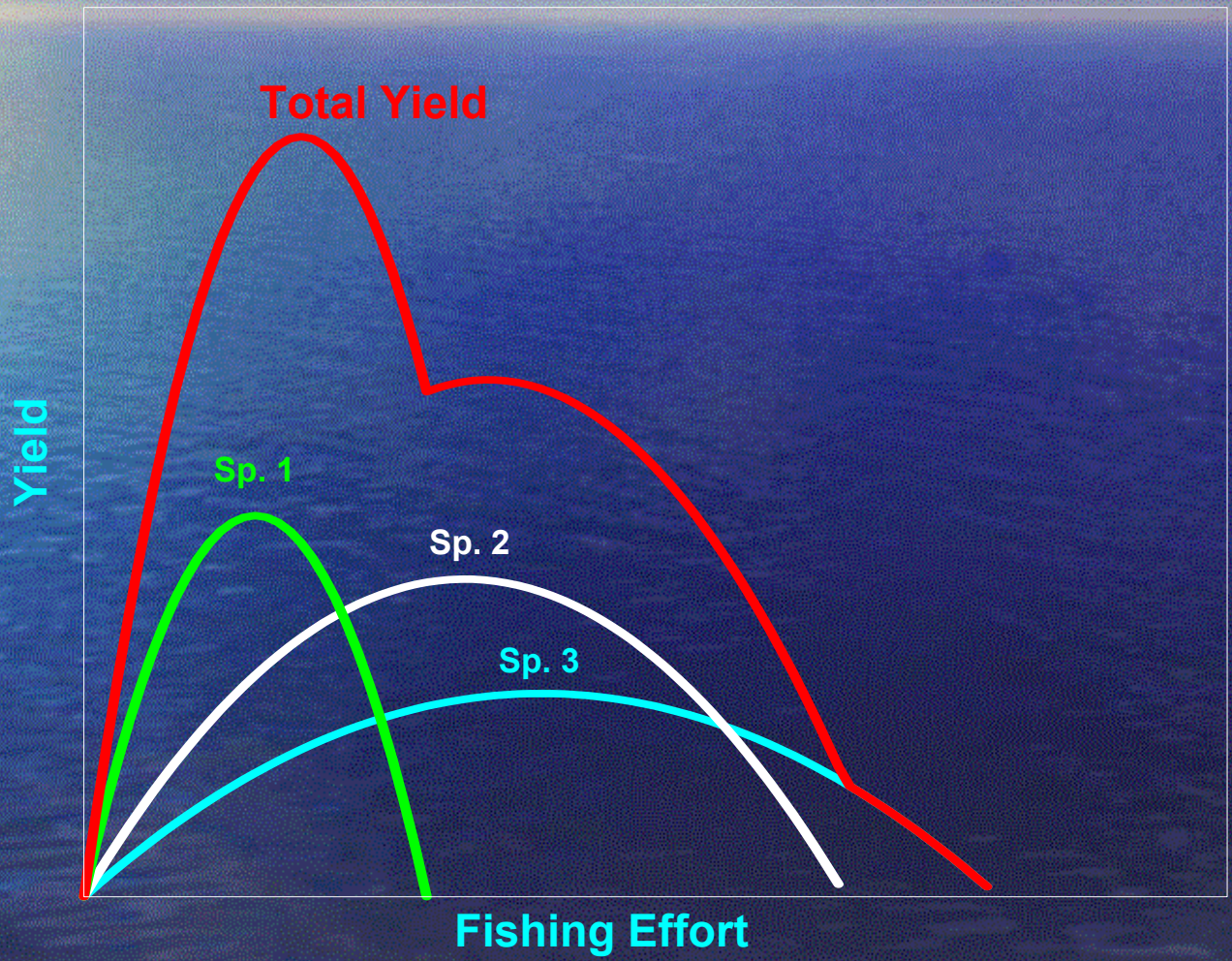


Multispecies Fisheries: Technological Interactions

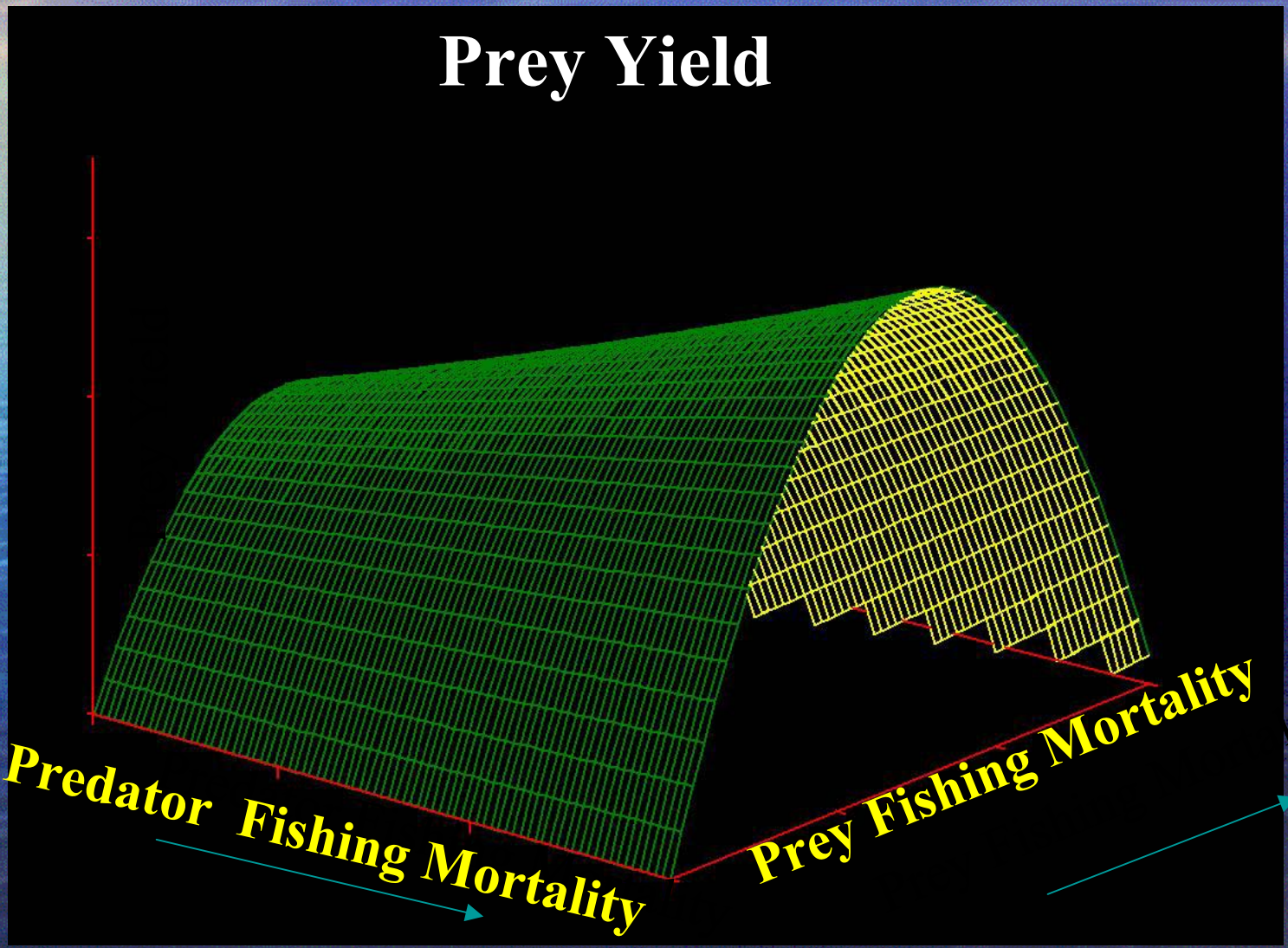
Multispecies Fisheries: Technological Interactions


Total Yield
Species 1
Production
Fishing Effort

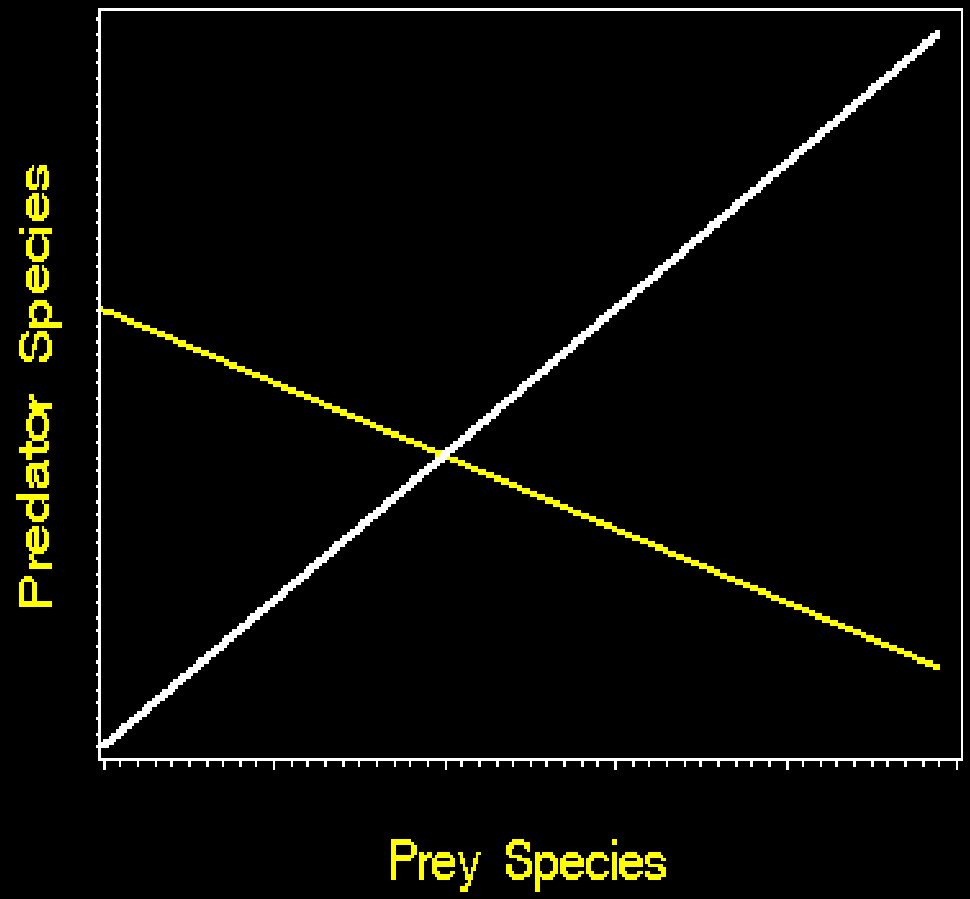

Total Yield
Species 1
Species 2
Production
Fishing Effort


Total Yield
Yield
Sp. 1
Sp. 2
Sp. 3
Fishing Effort

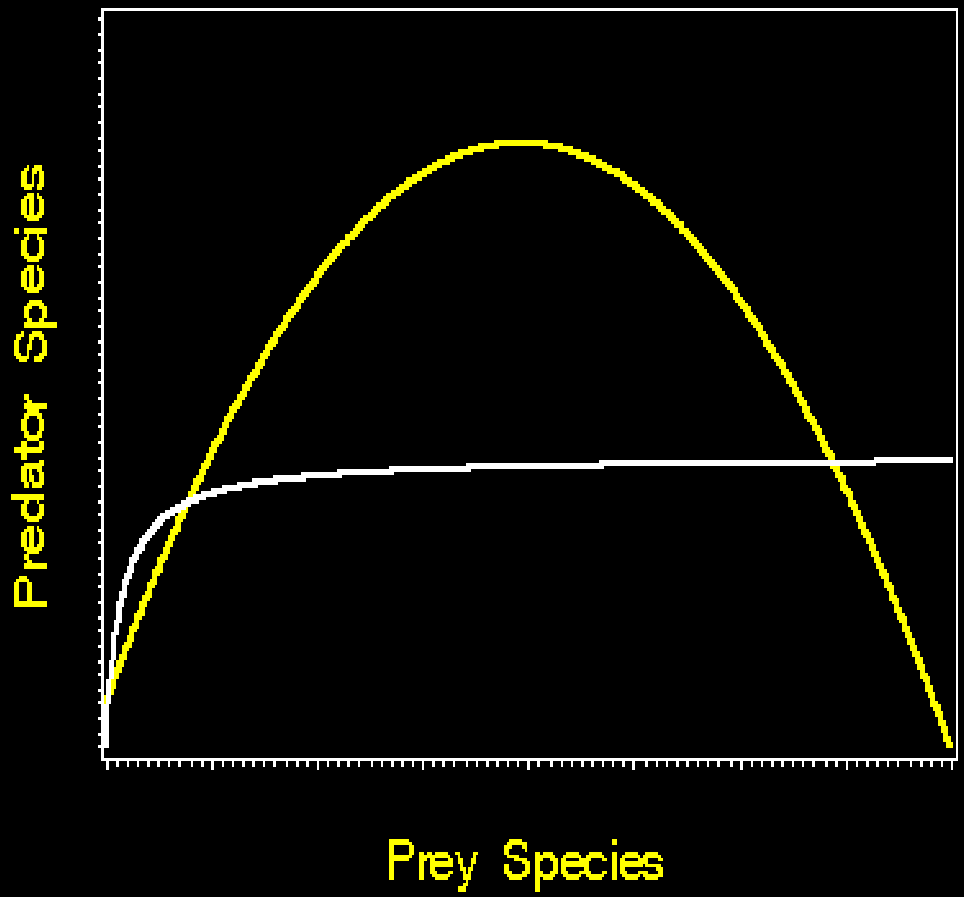
Multispecies Fisheries Biological Interactions



Predator-Prey Model: Type I Functional Response

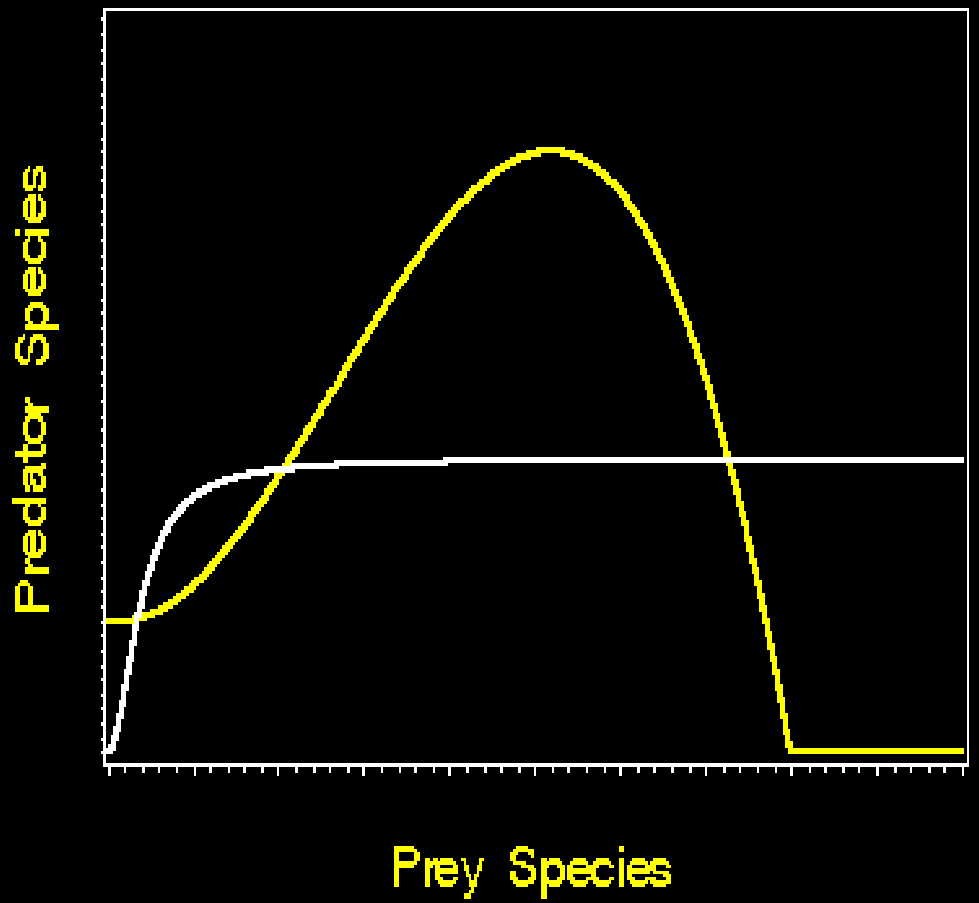


Predator-Prey Model: Type II Functional Response

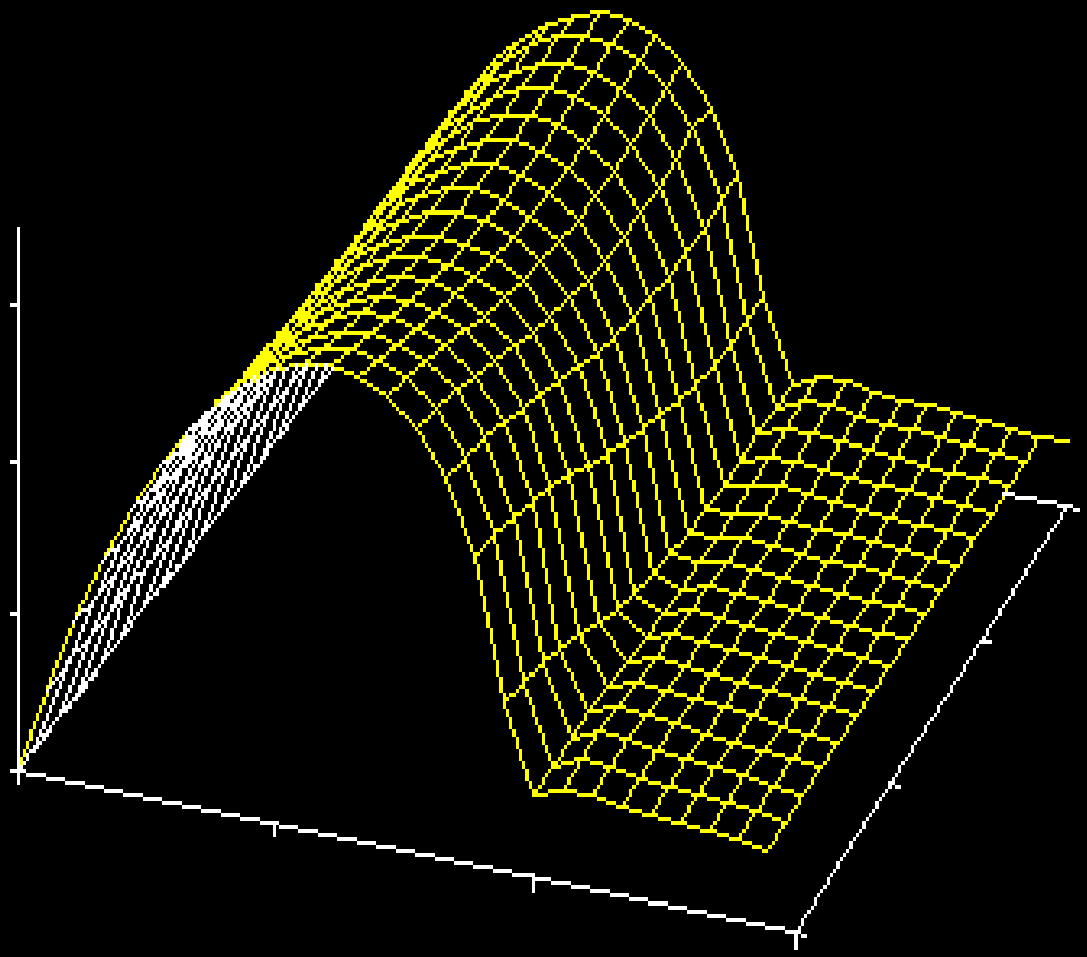


No Alternate Prey

Predator-Prey Model: Type III Functional Response



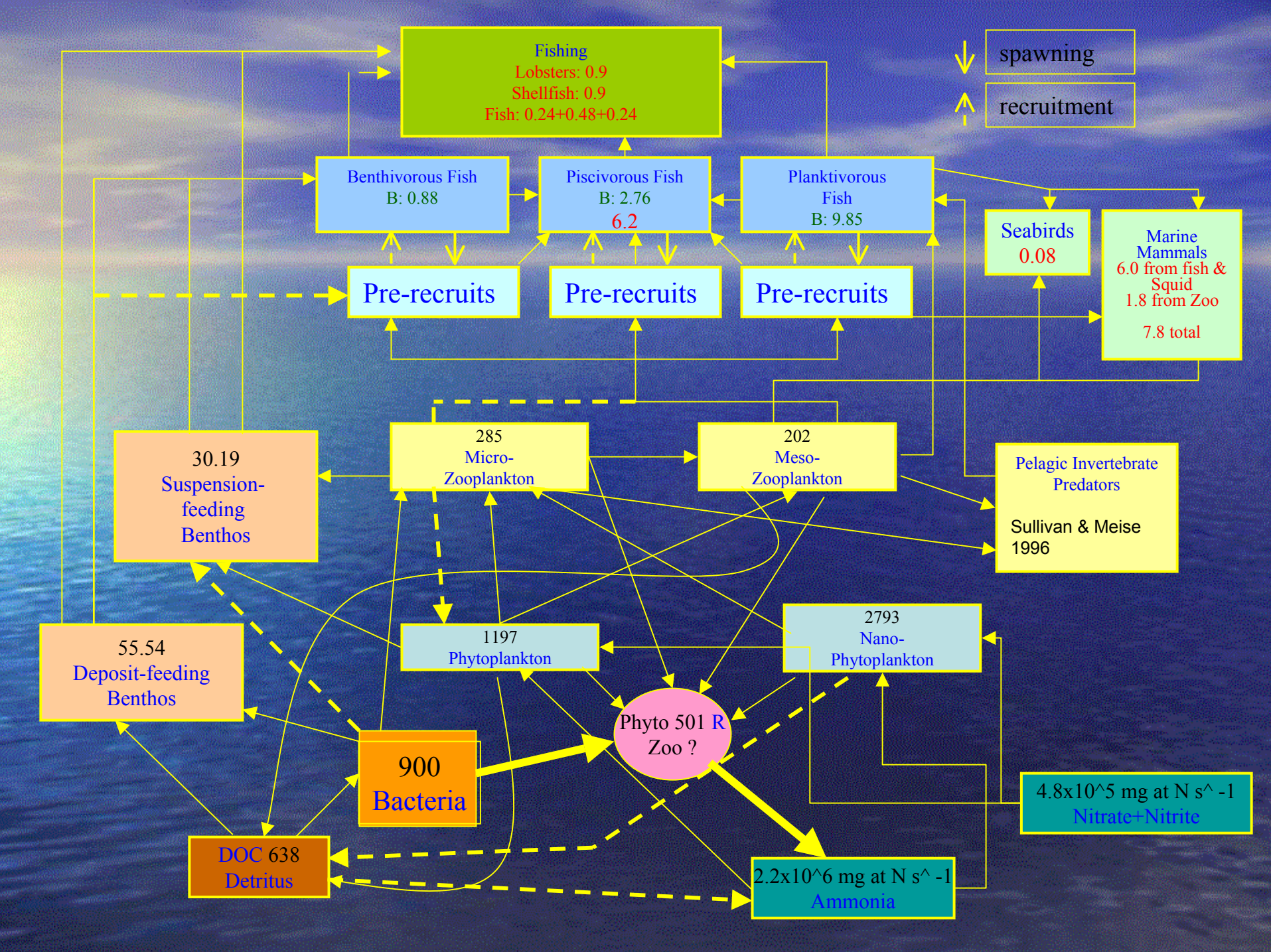
No Alternate Prey

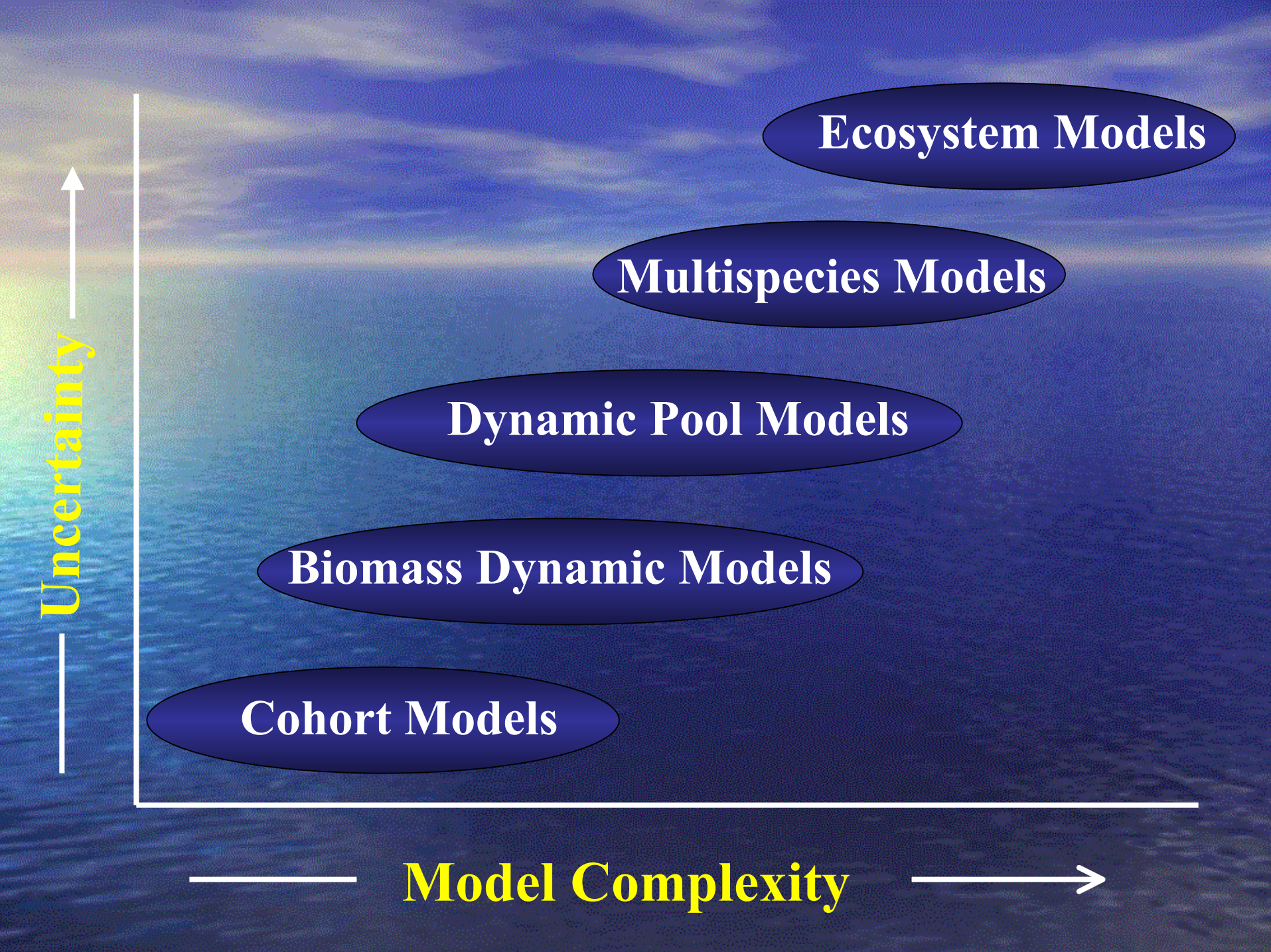


Production Contours: Competitive System

Production Contours: Competitive System

with Additional Constraint for Non-Target Species


Fishing
Lobsters: 0.9
Shellfish: 0.9
Fish: 0.24+0.48+0.24
spawning
recruitment
Benthivorous Fish
B: 0.88
Piscivorous Fish
B: 2.76
6.2
Planktivorous Fish
B: 9.85
Seabirds
0.08
Marine Mammals
6.0 from fish & Squid
1.8 from Zoo
7.8 total
Pre-recruits
Pre-recruits
Pre-recruits
30.19
Suspension-feeding Benthos
285
Micro-Zooplankton
202
Meso-Zooplankton
Pelagic Invertebrate Predators
Sullivan & Meise 1996
55.54
Deposit-feeding Benthos
1197
Phytoplankton
2793
Nano-Phytoplankton
Phyto 501 R
Zoo ?
900
Bacteria
4.8x10^5 mg at N s^ -1
Nitrate+Nitrite
DOC 638
Detritus
2.2x10^6 mg at N s^ -1
Ammonia

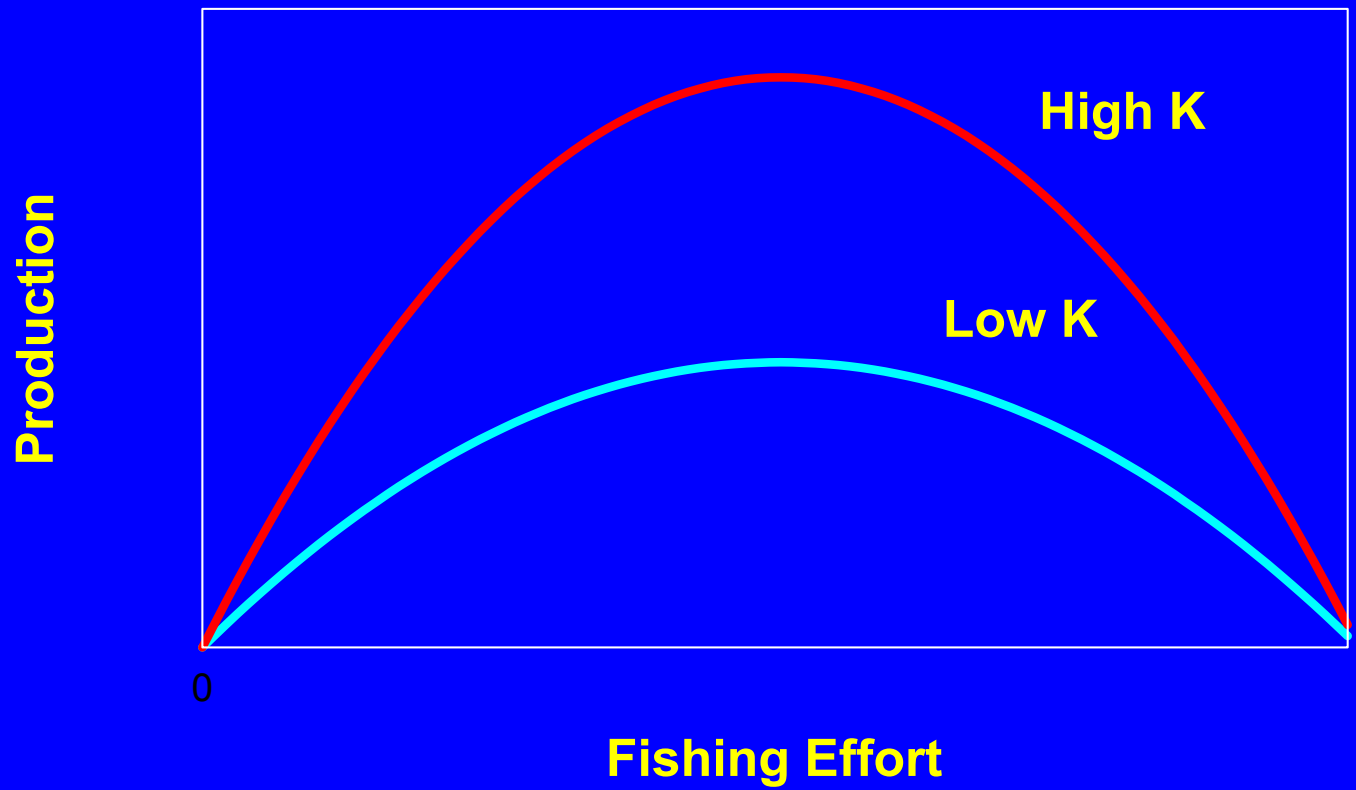

Ecosystem Models
Multispecies Models
Dynamic Pool Models
Biomass Dynamic Models
Cohort Models
Uncertainty
Model Complexity

To Optimize or Satisfice*?

Optimize: Find 'Best' Solution to a Specified Problem Under Certain Assumptions and Model Structures

Satisfice: Find a 'Good Enough' Solution to a Problem using Rules of Thumb or more Formal Methods using Artificial Intelligence Tools

*Herbert Simon: The Sciences of the Artificial


High K
Low K
Production
0
Fishing Effort